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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor:	William C. Hardy	
Serial No:	09/779,092	Group Art Unit: 2643
Filing Date:	02/08/2001	Examiner: Taylor, Barry W.
Title:	A METHOD AND APPARATUS FOR ESTIMATING QUALITY IN A TELEPHONIC VOICE CONNECTION	RESPONSE

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Kathryn A. Watson

Attention: Board of Patent Appeals and Interferences
Commissioner of Patents and Trademarks
Alexandria, VA 22313-1450

Sir:

BRIEF ON APPEAL

This Brief supports the appeal to the Board of Patent Appeals and Interferences from the final rejection dated April 3, 2003, in the application listed above. Appellants filed the Notice of Appeal on July 18, 2003 and now submit this Brief in triplicate, as required by 37 C.F.R. § 1.192(a).

I. REAL PARTY IN INTEREST

WorldCom, Inc., as assignee of U.S. Patent Application No. 09/779,092, is the real party in interest.

II. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences pertaining to the above identified application.

III. STATUS OF CLAIMS

A. Claims 1 – 61 are Finally Rejected

Claims 1 – 61 were rejected in the final Office Action dated April 3, 2003 as being unpatentable for obviousness over U.S. Patent No. 6,304,634 to Hollier et al. (hereinafter Hollier) in view of U.S. Patent No. 6,256,608 to Malvar, or Hollier in view of U.S. Patent No. 5,867,813 to Di Pietro et al. (hereinafter Di Pietro), or Hollier in view of U.S. Patent No. 6,356,601 to Chen et al. (hereinafter Chen).

B. Claims 1 – 61 Are On Appeal

The decision of the U.S. Patent and Trademark Office ("the Patent Office") that finally rejected claims 1 – 61 is hereby appealed.

IV. STATUS OF AMENDMENTS

No Amendments were filed after the Final Rejection.

V. SUMMARY OF INVENTION

A. Brief Description of the Invention

Appellants' invention is directed to a method, computer readable medium, and device for evaluating quality in a telephonic voice connection in a telecommunications network. The invention is also directed to a method for fabricating a device for

evaluating quality in a telephonic voice connection in a telecommunications network. The device includes a measurement circuit that is configured to measure one or more characteristics of the telephonic voice connection (Specification, at page 6, lines 15 – 32). A processor is coupled to the measurement circuit (Figure 1, Specification, at page 9, lines 12 - 26). The processor is programmed to calculate a solution to one or more empirically derived mathematical functions by using the measured characteristic(s) as an independent variable in the empirically derived mathematical function(s). The solution is an estimate of likely user perception of the quality of the telephonic voice connection (Specification, at page 10, lines 9 – 26).

B. Prior Art Problems Identified and Addressed

A poor connection or malfunctioning piece of equipment can produce conditions that a telephone customer will find objectionable or intolerable. The user's perception of the quality of service is a significant factor in the commercial success and reputation of that provider's long distance telephone services. When users experience a high incidence of poor quality, they are motivated to choose another long distance service provider (Specification, at page 1, lines 28 – page 2, line 6).

The poor quality of a telephonic connection may be due to certain impairments in the analog portion of the network, such as noise, attenuation, distortion, cross-talk and echo. Digital networks do not typically have these problems, but may suffer from other impairments, such as quantization noise and distortions due to bit errors in the digital signal. However, a typical telephone connection includes both analog components and digital components. Thus, a test device must be able to detect both types of impairments (Specification, at page 1, lines 20 – 27).

Long distance service providers have developed methods to obtain objective quality measurements upon a line, piece of equipment, or an end-to-end telephone connection. These measurements can help the service provider detect and gauge impairments, pinpoint weak elements, and correct deficiencies that degrade user perception of quality. The prior art does not, however, map objective measurements to user perceived quality ratings to generate an estimate of the perceived quality level for

the connection. Further, the prior art does not provide a real-time estimate of user perceived quality ratings (Specification, at page 2, lines 7 – 36).

The present invention addresses a need for a device that provides a real-time estimate, or near real-time estimate, of user perceived quality ratings using an empirically derived analytical expression. The present invention addresses this need by using an analytical representation of mapping tables developed in a parent application (i.e., application no. 09/220,773). By using a continuous mathematical function to obtain a real-time estimate of likely user perception of a given connection, CPU processing time is significantly reduced. Further, because mapping tables are replaced by one or more mathematical equations, the device is compact and cost-effective. The present invention also addresses a need for a reprogrammable device that can be updated as more accurate mapping data is obtained (Specification, at page 3, lines 5 – 12).

C. Detailed Description of the Present Invention

The present invention is directed to a method and device for evaluating quality in a telephonic voice connection in a telecommunications network. The method may be disposed on a computer readable medium in the form of computer executable instructions. The telecommunications network under test may be a circuit switched network, a packet switched network, or a hybrid that includes both circuit switched networks and packet switched networks (Specification, at page 9, lines 32 – 33).

The main components of the device include a measurement circuit and a processor circuit. The circuit used to measure characteristics of a telephonic connection may include several components. For example, a line interface 12 may be coupled to a relay 14, which distributes signals received from interface 12 to a DTMF (dual tone multi-frequency) transceiver 16, a PCM (pulse code modulation) codec 18, a call progress detector 20, and a voice detector 22 (Figure 1, Specification, at page 7, lines 5 – 8).

Signals from the network are translated by interface 12 into signals having a correct format and amplitude (Figure 1, Specification, at page 7, lines 14 – 15). DTMF transceiver 16 is operative to generate and detect audible tones associated with a telephone network. DTMF 16 is also adapted to generate DTMF dialing tones to initiate

a call through the telephone line coupled to interface 12 (Figure 1, Specification, at page 7, lines 18 – 21). PCM codec transceiver 18 uses a standard digitization scheme to band limit voice frequencies to the 300 – 3.3kHz frequency band. Codec 18 performs an A/D conversion of an analog voice message using a μ-law companding scheme (Figure 1, Specification, at page 7, lines 23 – 31). The Call Progress Detector 20 continuously monitors call progress information being fed to the device 10. (Figure 1, Specification, at page 7, line 32 - page 8, line 8). The Voice detect circuit 22 is fabricated using standard operation amplifier circuits to detect signals in the band between 750Hz and 4KHz. Voice detection may also trigger a response such that a test message is retrieved from memory 34 and converted into an analog signal by codec 18 for transmission over the telephone connection (Figure 1, Specification at page 8, lines 9 – 14).

During operation, processor 30 directs the above circuits to establish a voice connection with a customer location under test. A recorded message stored in memory 34 directs the customer to respond in various ways to message prompts. As a result, a voice sample and a quiet channel sample are obtained. The voice sample and the quiet channel sample yield measurements of the objective characteristics of the telephonic connection. The objective characteristics may include C-message noise, magnitude of average power of speech, magnitude of average power of a quiet channel, echo path delay, echo path loss, a speech distortion indicator, and a dropped frame rate in a packet switched network (Specification, at page 10, lines 5 – 13, claims 1 – 28). The device may also be disposed at the customer premises.

As will be described in more detail below, processor 30 uses the objective measurement as the independent variable of the empirically derived mathematical functions stored in memory 34, to calculate solutions to these functions (Specification, at page 10, lines 14 – 16, at page 12, line 20 – page 13, line 32).

In another aspect of the invention, device 10 may be reprogrammable. The empirical data used to formulate the instructions stored in memory 34 may become outdated. If this happens, reprogrammable device 10 is returned to a central location and reprogrammed with instructions representing the latest empirical data (Specification, at page 8, line 33 – page 9, line 11, at page 13, lines 17 – 32, claims 29 – 36). In this case, computer interface 28 is adapted to communicate with an external device 100 (Figure 1).

The programming instructions stored in memory 34 can be completely replaced or partially replaced with new instructions downloaded from external device 100. In yet another aspect of the invention, processor 30 may also be programmed to calculate a revised empirically derived mathematical function using the revised empirically derived data. This step is implemented on-chip by including a processing routine. The processing routine uses empirical data written into volatile memory to calculate coefficients used in the equations. Again, the empirical data is obtained via interface 28 (Specification, at page 8, line 33 – page 9, line 11, at page 14, lines 5 – 8, claim 61).

The present invention may be implemented as a computer readable medium having executable instructions disposed thereon. The memory 34 used to store the programming instructions used by processor 30 to perform the method of the present invention may be implemented using a DRAM, PROM, EEPROM, hard drive, compact disk, or any computer readable medium. Those of ordinary skill in the art will understand that memory 34 may be of any suitable type, including, for example, a read/write random access memory (RAM) used in data processing and data I/O, and an erasable read only memory for storing device 10 programming instructions used by processor 30, and a co-processor, depending on the sophistication of the embodiment (Figure 1, Specification, at page 8, lines 26 – 32, claims 49 – 60).

The present invention is also directed to a method for fabricating a device for evaluating quality in a telephonic voice connection in a telecommunications network. The method includes the step of empirically acquiring user perception data by having test subjects listen to a plurality of test messages, and rate the quality of each test message in accordance with at least one user perceived impairment characteristic (Figure 5, at step 502, Specification at page 11, lines 25 – 32). In the next step, the objective quality characteristics described above are selected. The subjective user perceived characteristics are then tied to the selected objective characteristics (Specification, at page 11, line 33 – page 12, line 8).

Subsequently, a plurality of test messages are generated. Each test message has a different combination of C-message noise, average power of speech, average power of quiet channel, echo path delay, echo path loss, distortion, or dropped frames. Next, subjective test subjects evaluate each of the generated test messages. Each evaluator will

listen to the series of test messages, which may be received in calls placed over a network in use, and rate each one in accordance with a "none," "some," or "much" standard. The generated user perception data is collected and quantified. Data tables are produced that summarize the percentages of user reports of none, some, and much impairment for each interval of the objectively measured voice connection characteristics (Figure 5, at steps 506 – 512, Specification at page 12, lines 9 – 19).

The user perception data in the data tables are modeled as a continuous analytical transform. P_m is defined as the likely percentage of users that would characterize a given voice connection as having much impairment. P_n is defined as the likely percentage of users that would characterize a given voice connection as having no impairment. P_s is defined as the likely percentage of users that would characterize a given voice connection as having some impairment (Specification at page 12, lines 20 – 25. claims 1 – 61).

The mathematical functions are graphically represented by a two dimensional curve. P_m is modeled as a smooth cumulative probability distribution function which takes on the value zero (0) for the best measured results and asymptotically increases to one (1) as the measured results become worse. P_m is expressed by the mathematical function:

$$P_m = 1 - \exp[-a(x-c)^b]$$

The smooth cumulative probability distribution function takes the form of an "s" curve (Figure 6, Specification at page 12, lines 26 – 32).

P_n is modeled as a smooth cumulative probability distribution function which takes on the value one (1) for the best measured results and asymptotically decreases to zero (0) as the measured results become worse. P_n is expressed by the mathematical function:

$$P_n = \exp[-d(x-c)^e].$$

The smooth cumulative probability distribution function takes the form of an inverse "s" curve (Figure 6, Specification at page 12, line 33 – page 13, line 7).

The above equations are added and subtracted from 1 to obtain P_s. Thus,

$$P_s = 1 - (P_n + P_m).$$

After combining terms,

$$P_s = \exp\,[-a(x-c)^b] - \exp\,[-d(x-c)^e].$$

P_s is a cumulative probability distribution function that achieves its maximum value somewhere between the extreme points set for the curves describing P_n and P_m (Figure 6, Specification at page 13, lines 8 – 14).

The shape of the curves are determined by a set of constants (a, b, c, d, and e) employed in the above equations. The above equations are fit to the empirical data in the data tables by using analytical and heuristic data fitting routines. These routines produce the desired continuous representation of the transition from $P_n = 1$ to $P_m = 1$ as the objective measured characteristic changes from very good to very bad (Specification at page 13, lines 17 – 24). These constants are programmed into device before use.

As noted above, processor 30 uses the objective measurement as the independent variable when solving the empirically derived mathematical functions (Specification, at page 10, lines 14 – 16). In the above equations, x is the independent variable representing the objective characteristic. The measured objective characteristic is plugged into the above equations to calculate the estimates of user percentages for the none, some, and much categories. For example, the constant "c" is a value for the objective measurement for which one would expect that there should be no complaint of impairment. Assuming the objective measure is C-message noise, setting x = c = 5dBrnc, the percentage of users deeming the connection to have no impairment would be close to 100%. Thus, the solution of each equation is an estimate of likely user perception of the quality of the telephonic voice connection (Figure 6, Specification at page 13, line 17 – page 14, line 19).

VI. ISSUES

Issues presented for consideration in this Appeal are:

A. Whether claims 1 – 61 are properly rejected under 35 U.S.C. § 103 for obviousness where the applied references would not have been properly combinable.

B. Whether claims 1 – 61 are properly rejected under 35 U.S.C. § 103 for

obviousness where the combination of the applied references does not teach the claimed invention.

VII. GROUPING OF CLAIMS

In compliance with 37 C.F.R. § 1.192(c)(5), Applicant states that claims 1 – 61 do not stand or fall together. Three groups of claims stand together as patentable. The groups include: (a) claims 1 – 28, and 49 – 60; (b) claims 29 – 36, and 61; and claims 37 – 48.

VIII. ARGUMENTS

A. Description of the prior art cited by the Examiner.

1. Hollier.

Hollier discloses a system for testing telecommunications equipment. The system includes connecting a first quality analysis device and a second quality analysis device to the telecommunications network under test. The first device and second device converse using artificial speech signals. The devices perform measurements on the sounds received from the other device. The device processes the received speech using a conversational processor and a perceptual analysis unit (See Figure 2, and column 9, lines 10-23, and lines 38-49). The perceptual analysis unit compares received speech with expected speech to analyze the quality of the received speech. The processor is coupled to the analysis unit and uses analysis unit inputs to control conversational intent. (See column 9, lines 17-22).

2. Malvar.

Malvar discloses a codec that is used to encode and decode digital signals for use in CDs, Internet audio, DVDs, and telephony. During transmission, the system includes an A/D converter that converts an analog audio signal into a digital representation of the audio signal, and a codec, which encodes and compresses the digital signal. The system also includes a decoder and D/A converter that performs the reverse process during reception of an encoded signal. The coder includes a MLT transform processor, a

weighting processor, a uniform quantizer, a spectrum processor, and entropy encoder, and a multiplexer (See column 3, lines 21-35).

The MLT transform processor receives an original signal and produces transform coefficients (See column 9, line 13 - column 13, line 22). The quantizer and the weighting processor employ spectral weighting and partial whitening in order to mask quantization noise (See column 13, line 23 - column 15, line 54). The weighting processor employs a bark scale (Column 13, line 43 – column 14, line 50).

The entropy encoder uses a probability model to measure the amount of information contained in a message and to perform variable-to-fixed length block encoding. The entropy encoder includes a run-length encoder and a Tunstall encoder. The run-length encoder reduces the symbol rate for sequences of zeroes by mapping variable length strings into source code words of a given length using a statistical model. The Tunstall encoder compresses the source code words (See column 15, line 55 to column 18, line 49). The statistical modeling used to perform entropy encoding uses a modified Laplacian-exponential probability density function (PDF) for the run-length encoding (See 18, line 50 - column 19, line 62). The PDF model is controlled by the parameter A (See column 19, lines 38-39). The parameter A is the maximum value of a fixed block (See column 18, lines 23-49).

3. Di Pietro

Di Pietro is directed to a method and apparatus for automatically and reproducibly rating the transmission quality of a speech transmission system such as a wireless system or a public switched telephone network (column 1, line 65 – column 2, line 15, and column 4, lines 48-52).

The apparatus generates a test signal containing a predetermined voice signal (column 5, lines 16 – 55). The test signal is transmitted from a system transmitter to a system receiver. Characteristic values are extracted from the received signal. In this case, the characteristic values refer to coefficients that determine the envelope of the logarithmic spectral power of the received signal (column 7, lines 5 – 34).

A differential pattern corresponding to the difference between the characteristic values and the predetermined reference values is derived. The differential pattern is used

as an input to a neural network (column 5, lines 34 – 51). The neural network is trained to classify such patterns according to a predetermined number of transmission quality classes, such as "good," "medium" and "bad" (column 5, lines 55 – 63).

4. Chen

Chen is directed to a method and apparatus for detecting zero rate frames in a communications system, such as in a wireless system that employs code division multiple access (CDMA).

In CDMA systems, transmissions occur within specified time intervals referred to as frames. The duration of a frame may be on the order of 20msec. The amount of data transmitted in a frame may be variable. A zero rate frame is a frame that includes no data transmission. CDMA systems often reduce transmitted power during the zero rate frame for efficiency reasons, e.g., reduce transmitted power when no data is being transmitted. Thus, it is critical that the receiver be able to detect the incidence of zero rate frames because it must be able to differentiate between an erased or bad frame (e.g., an error condition) and a zero rate frame, which is a normal network condition (Column 1, lines 29 – 61).

Thus, Chen solves the problem of detecting zero rate frames. Chen does not solve the problem of detecting dropped packets. In detecting zero rate frames, the receiver demodulates the received signal to obtain demodulated symbols. The demodulated symbols are partitioned into frames. A quality metric is derived from each frame. The quality metric may be the energy of the received frame, the distance between the received frame and a predetermined codeword, or some other metric (Column 2, lines 2 – 59). Typically the quality metric is compared to a threshold (Figure 5, column 9, lines 28 – 44).

The threshold is determined by the relationship of two Gaussian PDFs. One Gaussian PDF is used to represent a zero rate frame which includes only noise (e.g., no signal is present in the communications channel). The mean and standard deviation of PDF is estimated using the metrics of known zero rate frames. The other represents a non-zero rate frame. The Gaussian PDF represents a frame that includes both signal and noise. The mean and standard deviation of the PDFs are estimated using the metrics of

known good and bad frames (column 11, lines 54 – 57). In this case, the computed energy of the received frame determines the distance between a first PDF and a second PDF (column 11, lines 30-32), and hence, the threshold. When the metric is less than the threshold, the frame is deemed a zero rate frame. As those of ordinary skill in the art will recognize, the Gaussian distribution is a well known function that is defined by its mean and standard deviation (column 12, lines 3-10).

D. Claims 1 – 61 are patentable under 35 U.S.C. § 103(a) because Hollier, Malvar, Di Pietro, and Chen would not have been properly combinable.

In the final Office Action of April 3, 2003, the Examiner rejected pending claims 1 – 61 under 35 U.S.C. § 103 as being unpatentable over Hollier in view of Malvar or Di Pietro or Chen. On page 4 of the final Office Action, the Examiner stated that:

> "It would have been obvious for anyone of ordinary skill in the art at the time the invention was made to modify the codec as taught by Hollier to utilizes [sic] a probability density function that classify [sic] signals as taught by Malvar or Di Pietro or Chen so that the codec may classify a signal or set a value that a desired outcome may be achieved."

The PTO may not properly combine prior art references in order to establish *prima facie* obviousness unless there is "some suggestion for doing so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art." *In re Jones,* 21 USPQ2d 1941, 1943 – 44 (Fed. Cir. 1992); See also *In re Geiger,* 2 USPQ2d 1276, 1278 (Fed. Cir. 1987). Thus, obviousness cannot be demonstrated by combining prior art references absent some teaching, suggestion or incentive supporting the combination.

In this case, the Examiner's statement fails to point to any place in any of the references where a suggestion to combine may be found. Further, the Examiner's statement fails to point to any source of knowledge generally available to those of ordinary skill in the art where a suggestion to combine these references may be found. Moreover, the Examiner's motivational statement is ambiguous, inasmuch as classifying

"a signal or set a value that a desired outcome may be achieved" can mean anything or nothing.

Applicant respectfully submits that the Examiner failed to provide a *prima facie* case of obviousness because one of ordinary skill in the art would not be motivated to use or modify the teaching of Hollier to obtain Applicant's invention. In re Vaeck, 20 U.S.P.Q.2d 1438, 1442 (Fed. Cir. 1991). The Examiner did not, and is unable to, point to any place in either Malvar, Di Pietro, or Chen, where it suggests or provides a motive to modify the Hollier device for simulating human conversational behavior over a communications system, to obtain a device for evaluating the quality of a telephonic connection in the manner claimed by the Applicant. Instead, extraneous to the references and contrary to the PTO's own rules, the Examiner suggests, without explaining or citing support, that it is desirable to use Malvar's system of encoding and decoding digitized audio signals in Hollier's system for testing a network. Hollier seeks to test network performance, whereas Malvar provides a codec that overcomes audio system limitations. Presumably, the use of the codec would mask the very problems that Hollier is trying to uncover. Alternatively, the Examiner suggests, without explaining or citing support, that it is desirable to use Di Pietro's neural network in Hollier's system for simulating a human conversation over a network. Di Pietro transmits a recording to a remote receiver and analyzes the recording using the neural network. Hollier on the other hand employs a conversational processor to simulate the give and take of a human conversation. The benefit of using the neural network has not been explained. Also, the present invention does not use a neural network. Thus, Appellant respectfully submits that Di Pietro is irrelevant. Finally, the Examiner suggests, without explaining or citing support, that it is desirable to use Chen's system for detecting zero rate frames in Hollier's system for simulating a human conversation over a network. Again, the present invention is nit directed to detecting zero rate frames. Thus, Appellant respectfully submits that Chen is also irrelevant. See M.P.E.P. § 706.02(a).

The appellant asserts that the examiner's motivational statement is mere hindsight. The U.S. Court of Appeals for the Federal Circuit has emphasized that an Examiner "cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention." Fine, 5 U.S.P.Q.2d at

1600. The Examiner agrees that Hollier does not disclose a processor operative to calculate a solution to at least one empirically derived mathematical function by using at least one measured characteristic as an independent variable. As pointed out above, the other cited references do not have this feature either. In the instant case, the Examiner, now with the claimed invention in mind, has selected and joined isolated parts of four references to assert Applicant's invention would have been obvious "to utilize a probability density function...to achieve a desired outcome."

If a proposed modification renders the prior art invention being modified, unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 221 USPQ 1125 (Fed. Cir. 1984). In this case Hollier's invention is directed to a method for evaluating the quality of service in a network. Malvar discloses an improved codec that handles degraded speech, as well as clean speech (Column 2, lines 33-45). Malvar's codec is also robust when it comes to packet losses. It is simply inconceivable that one skilled in the art would use a codec that masks network problems in a device designed to detect network problems. Rather, one skilled in the art would use a codec that provides an accurate condition of the network-under-test. Further, the claims recite a processor, not a codec. With respect to Di Pietro, the Examiner fails to point out how Di Pietro's neural network would be employed in Hollier's system to arrive at the appellant's invention. Each of these references operate using different principles. Hollier seeks to simulate human conversational patterns. Di Pietro employs a recorded message and uses a neural network to learn how to classify differential patterns. Thus, using Di Pietro's neural network in Hollier would necessarily change the way Hollier operates, replacing the conversational processor with the neural network. Finally, Chen's invention is for detecting zero rate frames in a CDMA system. The Examiner fails to explain why a zero rate frame detector is applicable to Hollier's method for evaluating the quality of service in a network.

For the reasons provided above, Appellant respectfully submits that the rejection of claims 1 – 61as being unpatentable for obviousness under 35 U.S.C. §103(a) is improper, and should be withdrawn.

E. <u>Even assuming, strictly *arguendo*, that Hollier and Malvar or Di Pietro or</u>

<u>Chen are properly combinable, the combination of these references does not teach the claimed invention.</u>

Group 1

For all the reasons stated *supra*, there would have been no reason to combine these references. However, even assuming *arguendo* that such a combination were proper, it still would not teach the present invention as recited in claim 1, claim 18 and claim 49.

Neither Hollier, Malvar, Di Pietro, nor Chen, whether taken alone, or in combination, teach, suggest or disclose a device or method that calculates a solution to at least one empirically derived mathematical function by using the at least one measured characteristic as an independent variable in the at least one empirically derived mathematically function, whereby the solution is an estimate of likely user perception of the quality of the telephonic voice connection, as recited in claim 1, claim 18, and claim 49.

As noted throughout prosecution, the Examiner states (in both Office Actions) that Hollier teaches a system and method for evaluating quality in a telephonic voice connection. He also states that Hollier's system includes a measuring circuit and a processor, as recited in claim 1. In making his rejection, the Examiner relies on the Title, Abstract, col. 1, line 8 - column 4, line 67, column 5, line 12 - column 6, line 67, and column 7, line 25 - column 16, line 34. As pointed out in all of the appellant's responses, the Examiner does not point out where in these large blocks of text the individual elements can be found. The Examiner has failed to make a prima facie case of obviousness because he has failed to point out where all of the claim limitations can be found in the references.

In the Background of the Invention (Columns 1-2), Hollier describes the development of various techniques used to characterize the quality of a network. Hollier states that there are essentially two ways to determine network quality. First, an objective analysis may be employed. Examples of objective analyses include signal-to-noise measurements. Hollier dismisses the use of objective methods, because they neglect user perception, or because they use signals (such as sine waves) not normally transmitted over the network (See column 1, lines 37-50, and column 2, lines 7-15). The claimed

invention does employ objectively measured characteristics as the independent variable in empirically derived equations. Thus, Hollier teaches away from the present invention.

Hollier describes a mean opinion score (MOS) method, a conversational assessment method, an artificially generated speech method. However, the MOS Method is a static analysis that uses post-processing techniques. As explained by Hollier, the MOS is derived by subjects rating the quality using a five point scale ranging from "excellent" to "bad". Further, the MOS as described in Hollier does not use an empirically derived mathematical function, as recited in the claimed invention (column 1, lines 17-29, and column 1, lines 50 - column 2, line 29).

Hollier's conversational assessment method, which varies vocal level until "equilibrium is achieved," does not solve an empirically derived mathematical function to determine quality (See column 2, lines 30-40). The artificially generated speech method uses precisely defined and easily reproducible phonemes. Received artificial speech is compared with stored speech (See column 2, lines 41-48). This method also does not solve an empirically derived mathematical function to determine quality. Thus, contrary to the Examiner's assertions, the Background of Hollier's invention does not teach, suggest, or disclose the processor, as recited in the claimed invention.

Hollier discloses a system for testing telecommunications equipment that includes connecting a first quality analysis device and a second quality analysis device to a telecommunications network. The first device and second device converse using speech signals. The receiving device includes a conversational processor and a perceptual analysis unit programmed to react to the received speech (See Figure 2, and Column 9, lines 10-23, and lines 38-49). The perceptual analysis unit compares received speech with expected speech to analyze the quality of the received speech (Column 9, lines 38-41). In response, the processor updates and controls the conversational states to adapt conversational intent and recovery behavior to the received speech (Column 9, lines 41-44). A description of a conversational assessment of a two-device system is shown in Figures 3-6, and described at column 9, line 53-column 12, line 54.

In light of the analysis of the text cited by the Examiner, Hollier does not teach a processor operative to calculate a solution to at least one empirically derived mathematical function by using the at least one measured characteristic as an independent

variable in the at least one empirically derived mathematically function, whereby the solution is an estimate of likely user perception of the quality of the telephonic voice connection, as recited in the claimed invention.

The combination of Hollier and Malvar

The Examiner states that Malvar provides the elements missing from Hollier. In particular, the Examiner asserts that Malvar teaches a system that uses "real-time parametric modeling for a probability distribution function that approximates the user perception of the quality of a voice connection." The Examiner has yet to point out where this statement can be found in the Malvar reference. It is simply not accurate. The appellant has repeatedly asked the Examiner to point to where Malvar teaches the step of calculating the solution to empirically derived mathematical functions using measured characteristics as an independent variable, as recited in the claims. The Examiner has not done so.

Malvar does not remedy Hollier's deficiencies for several reasons. First, Malvar is not directed to a system for evaluating quality in a telecommunications network. Malvar discloses a codec that performs entropy encoding (See Title, Abstract, column 2, lines 15-18, column 3, line 14-column 4, line 11). Second, Malvar does not teach or suggest a processor for calculating a solution to at least one empirically derived mathematical function by using the at least one measured characteristic as an independent variable in the at least one empirically derived mathematical function, whereby the solution is an estimate of likely user perception of the quality of the telephonic voice connection, as recited by the claimed invention. Malvar teaches a codec that encodes and decodes digital signals (See column 3, lines 14-20). Malvar is not directed to evaluating system quality, rather it is directed to improving system quality by way of a superior codec. Malvar employs a modified Laplacian-exponential probability density function (PDF) for a run-length encoding step within the overall entropy encoding process (See 18, line 50-column 19, line 62). The Laplacian-exponential PDF model is controlled by the parameter A (See column 19, line 38-39), which is defined as the maximum value of a fixed block (See column 18, lines 23-49). Thus, the parameter A is not a measured characteristic of a telephonic voice connection. Furthermore, the Laplacian-exponential

PDF model is not employed to approximate user perception of the quality of a voice connection.

Appellant respectfully submits that Malvar does not teach any limitations of the claimed invention. Whether taken alone, or in combination, neither Hollier nor Malvar teach or suggest the claimed invention.

For the reasons provided above, Appellant respectfully submits that the rejection of claims 1 – 28 and 49 – 60 under 35 U.S.C. §103(a), as being obvious over Hollier in view of Malvar, is improper, and should be withdrawn.

The combination of Hollier and Di Pietro

The Examiner also asserts that Di Pietro supplies the elements missing from Hollier. The Examiner correctly states that Di Pietro teaches a method and apparatus for rating the transmission quality of a speech system, wherein differential data is fed to a neural network. The Examiner also correctly asserts that Di Pietro discloses a "non-linear" function having "x" as the argument of the non-linear function (column 8, lines 45 – 50). Note, however, that the claimed invention is not directed to a neural network and does not recite a non-linear function. Rather, the claimed invention recites an empirically derived function.

Indeed, appellant respectfully submits that Di Pietro is irrelevant to the claimed invention. Like Hollier, Di Pietro does not teach, suggest, or disclose a processor operative to calculate a solution to at least one empirically derived mathematical function by using the at least one measured characteristic as an independent variable in the at least one empirically derived mathematical function, whereby the solution is an estimate of likely user perception of the quality of the telephonic voice connection, as recited in the claimed invention. In fact, Di Pietro does not teach any of limitations of the claimed invention. Whether taken alone, or in combination, neither Hollier nor Di Pietro teach or suggest the claimed invention.

For the reasons provided above, Appellant respectfully submits that the rejection of claims 1 – 28 and 49 – 60 under 35 U.S.C. §103(a) as being obvious over Hollier in view of Di Pietro is improper, and should be withdrawn.

The combination of Hollier and Chen

The Examiner correctly asserts that Chen teaches a method and apparatus for detecting zero rate frames by comparing a computer metric to a threshold value. The threshold value is determined by plotting two PDFs. However, Appellant respectfully submits that the Examiner's analysis, once again, misses the point. The subject matter of the present invention has nothing to do with zero rate frame detection.

In Chen, the intersection of the two PDFs determines a threshold which in turn, determines whether a frame is a zero rate frame. If the frame energy is below the threshold it is deemed a zero rate frame. If it is above, it is not deemed a zero rate frame. Thus, neither PDF is employed to calculate a solution to an empirically derived mathematical function by using the at least one measured characteristic as an independent variable in the at least one empirically derived mathematical function, whereby the solution is an estimate of likely user perception of the quality of the telephonic voice connection, as recited in the claimed invention.

Like the other references, Appellant respectfully submits that Chen does not teach any of limitations of the claimed invention. Whether taken alone, or in combination, neither Hollier nor Chen teach or suggest the claimed invention.

Accordingly, Appellant respectfully submits that the rejection of claims 1 – 28 and 49 – 60 under 35 U.S.C. §103(a) as being obvious over Hollier in view of Chen is improper, and should be withdrawn.

Appellant also respectfully points out that claims depending from claim 1, claim 18, and claim 49 are allowable in their own right. For example, the equations recited in the dependent claims 3 – 8, 19 – 22, and 51 – 53 are simply not taught by the references. The Examiner has failed to point out where the references teach the recited equations.

For the reasons provided above, Appellant respectfully submits that the rejection of claims 1 – 28 and 49 – 60 under 35 U.S.C. §103(a) as being obvious over Hollier in view of Malvar, Di Pietro, or Chen is improper, and should be withdrawn.

Group 2

For all the reasons stated *supra*, there would have been no reason to combine the cited references. However, even assuming *arguendo* that such a combination were

proper, it still would not teach the present invention as recited in claim 29 and claim 61.

Claim 29 and claim 61 are allowable for at least the reasons that claims 1, 18 and 49 are allowable. Moreover, claim 29 and 61 have additional distinguishing features.

The Examiner has failed to provide an independent analysis of claim 29 and claim 61. Claim 29 and claim 61 are directed to a programmable device for evaluating quality in a telephonic voice connection in a telecommunications network. The Examiner does not point out where either Hollier, Malvar, Di Pietro or Chen disclose a programmable device as recited in the claimed invention.

Claim 29 and claim 61include a memory operative to store at least one empirically derived mathematical function having at least one independent variable. Claim 29 also includes an interface control circuit adapted to receive revised empirically derived data from an external device, and store the revised empirically derived data in the memory. The Examiner does not point out where in either Hollier, Malvar, Di Pietro or Chen either of these elements can be found.

Claim 61 recites a processor programmed to calculate a revised empirically derived mathematical function using the revised empirically derived data. The processor calculates a solution to the revised at least one empirically derived mathematical function by using at least one measured characteristic as the independent variable. The solution is an estimate of likely user perception of the quality of the telephonic voice connection. The Examiner does not point out where in either Hollier, Malvar, Di Pietro or Chen this element can be found.

Claims depending from claim 29 are allowable in their own right. For example, the equations recited in the dependent claims 31 – 33 are simply not taught by the references. Whether taken alone, or in combination, the Examiner fails to point out where either Hollier, Malvar, Di Pietro or Chen teach or suggest the claimed invention.

For the reasons provided above, the rejection of claims 29 – 36 and claim 61 under 35 U.S.C. §103(a) is improper, and should be withdrawn.

Group 3

For all the reasons stated *supra*, there would have been no reason to combine these references. However, even assuming *arguendo* that such a combination were

proper it still would not teach the present invention as recited in claim 37.

The Examiner does not provide an independent analysis of claim 37. Claim 37 is directed to a method for fabricating a device for evaluating quality in a telephonic voice connection in a telecommunications network. The Examiner does not point out where this method can be found in either Hollier, Malvar, Di Pietro or Chen.

The Examiner asserts that "claim 37 is nothing more than the combination of previously rejected claims 1, 18 and 29." Applicant respectfully submits that claim 37 is not merely the combination of claims 1, 18 and 29. Claim 37 recites different limitations and possesses different scope than that provided by the combination of claims cited by the Examiner. For example, the method includes the step of empirically acquiring user perception data by having at least one test subject listen to a plurality of test messages, and rate the quality of each test message in accordance with at least one user perceived impairment characteristic. The user perception data is modeled as at least one mathematical function. The Examiner does not point out where this step is found in any of the cited references.

The at least one mathematical function is graphically represented by a two dimensional curve having a shape, the shape of the curve being determined by a set of constants employed in the at least one mathematical function. The Examiner does not point out where this step is found in any of the cited references.

The method also includes the step of choosing values for the set of constants to thereby fit the two-dimensional curve to the user perception data to the thereby generate at least one empirically derived mathematical function. The Examiner has not pointed out where this step is found in any of the cited references.

The method also includes the step of converting the at least one empirically derived mathematical function into a set of computer executable instructions. The step includes the limitation that the device is programmed with the set of computer executable instructions. The Examiner has not pointed out where this step is found in any of the cited references.

The claims depending from claim 37 are also patentable in their own right. For example, none of the cited references disclose, teach or suggest using the objective measurements recited in claim 39. None of the cited references disclose, teach or suggest

any of the empirically derived equations recited in claims 42-48. Whether taken alone, or in combination, the Examiner fails to point out where Hollier, Malvar, Di Pietro or Chen teach or suggest the claimed invention.

For the reasons provided above, Appellant respectfully submits that the rejection of claims 37 – 48 under 35 U.S.C. §103(a) is improper, and should be withdrawn.

F. Response to Examiner's Advisory Action

The appellant follows the order of the Examiner's response:

1.

a) The Examiner relies on Malvar's teaching of a Bark scale for the proposition that Malvar uses it to approximate user perception of the quality of voice connection. The Examiner cites "column 13, line 43+" for this proposition (Page 9, Final Office Action). The Appellant has repeatedly pointed out to the Examiner that the cited text states that "a Bark scale is a quasi-logarithmic scale that approximates the critical frequency bands of the human ear" (Column 13, lines 45 – 50). The Bark scale is used by Malvar for spectral weighting purposes. Spectral weighting is used to mask quantization noise (Column 13, lines 30 – 35). In response to the appellant's points, the Examiner continues to repeat his original comments. The Examiner has a duty to provide appellant with a reasoned response for each point made. He has not done so.

The Examiner refers to U.S. Patent No. 5,715,372 (Meyers et al.) for a teaching of voice coders that calculate a mean opinion score (MOS). If the Examiner seeks to rely on Meyers, he should withdraw the finality of the rejection and issue a non-final rejection.

b) The Examiner again asserts that a Bark scale is a "probability distribution function that approximates the user's perception of the quality of a voice connection." This is incorrect. Again, the appellant has pointed out to the examiner that the cited text does not support his assertions. Referring back to the text cited by the Examiner, "a Bark scale is a quasi-logarithmic scale that approximates the critical frequency bands of the human ear" (Column 13, lines 45 – 50). In response to the appellant's points, the Examiner continues to repeat his original comments. The Examiner has a duty to provide appellant with a reasoned response for each point made. He has not done so.

c) The Examiner provides two new references to support his erroneous contention that a Bark Scale is a "probability distribution function that approximates the user's perception of the quality of a voice connection." If the Examiner seeks to rely on these references, he should withdraw the finality of the rejection and issue a non-final rejection.

d) Regarding the Chen reference, the Examiner states that the appellant's comments are "irrelevant" because "Applicant fails to define or argue Applicant's invention, nor do Applicant's exclude and/or include the 'Gaussian distribution' in the Applicant's independent claim." The appellant respectfully submits that the invention has been clearly defined. Namely, the claimed invention calculates a solution to an empirically derived mathematical function using a measured characteristic as an independent variable. The solution is an estimate of likely user perception. Appellant respectfully submits that Chen includes no such feature, and that whether the functions described in Chen are Gaussian is immaterial.

e.) Again, the Examiner refuses to provide a cogent explanation as to why he disagrees with the appellant's arguments. He merely states that he disagrees and repeats the same points that he made in the first rejection. This is improper.

f. – i.) The Examiner again asserts that he does not have to provide an independent examination of each claim. Appellant has pointed out repeatedly that he is entitled to an examination of every claim. For example, claim 37 is a method of fabricating a device. Accordingly, all of the claim steps are unique. The Examiner has not examined the claim. As another example, claim 61 recites that the processor calculates a revised set of empirical equations. That limitation is likewise not recited in any of the other claims. The Examiner refuses to examine this claim as well.

k.) The Examiner once again fails to provide any reasoning when it comes to appellant's argument that the references are not combinable. The Examiner simply repeats text found in the original office action. The appellant has a right to a reasoned response to his arguments.

2. The Applicant's pointed out in the response to the Examiner's final rejection that Meyers was not part of the rejection, and therefore was irrelevant. If the Examiner

wants to use Meyers in the rejection of the claims, he should withdraw the final rejection. Appellant cannot respond to a rejection not of record.

G. Request for an Interview

Appellant's representative attempted to contact the Examiner's Supervisor, Curtis Kuntz, on Friday, August 15, 2003. The appellant's representative left a message on the supervisor's voice mail. In the message, the appellant's representative detailed some of the issues and the Examiner's lack of response in this case. To date, the supervisor has not returned the call.

IX. CONCLUSION

In conclusion, Appellant requests a reversal of each of the grounds of rejection maintained by the Examiner. If there are any other fees due in connection with the filing of this Brief on Appeal, please charge the fees to WorldCom Deposit Account No. 13-2491. If a fee is required for an extension of time under 37 C.F.R. § 1.136 not accounted for above, such an extension is requested and the fee should also be charged to the WorldCom Deposit Account.

Respectfully submitted,

Wall Marjama & Bilinski

Date: September 22, 2003

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APPENDIX TO BRIEF ON APPEAL

The claims on appeal are as follows:

1. A device for evaluating quality in a telephonic voice connection in a telecommunications network, the device comprising:
   a measurement circuit operative to measure at least one characteristic of the telephonic voice connection; and
   a processor coupled to the measurement circuit, the processor being operative to calculate a solution to at least one empirically derived mathematical function by using the at least one measured characteristic as an independent variable in the at least one empirically derived mathematical function, whereby the solution is an estimate of likely user perception of the quality of the telephonic voice connection.

2. The device of claim 1, wherein the at least one empirically derived mathematical function is a cumulative probability distribution function.

3. The device of claim 1, wherein the at least one empirically derived mathematical function includes a first function (P_N) representing a proportion of users that will perceive the telephonic voice connection as having no impairment, a second function (P_S) representing a proportion of users that will perceive the telephonic voice connection as having some impairment, and a third function (P_M) representing a proportion of users that will perceive the telephonic voice connection as having much impairment, where $P_N + P_S + P_M = 1$.

4. The device of claim 3, wherein the first function includes the equation
   $P_N = \exp\,[-a(x-c)^b]$.

5. The device of claim 4, wherein a and b are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

6. The device of claim 3, wherein the third function includes the equation

$$P_M = 1 - \exp[-d(x-c)^e].$$

7. The device of claim 6, wherein d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

8. The device of claim 3, wherein the second function is characterized by the equation

$$P_S = \exp[-a(x-c)^b] - \exp[-d(x-c)^e].$$

9. The device of claim 8, wherein a, b, d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

10. The device of claim 1, wherein the at least one characteristic is selected from the group consisting of C-message noise, magnitude of average power of speech, magnitude of average power of a quiet channel, echo path delay, echo path loss, a speech distortion indicator, and a dropped frame rate in a packet switched network.

11. The device of claim 1, wherein the network is a packet switched network

12. The device of claim 1, wherein the network is a circuit switched network.

13. The device of claim 1, further comprising a network interface coupled to the measurement circuit, the network interface being operative to establish the telephonic voice connection between the device and the network.

14. The device of claim 1, further comprising:

a memory operative to store at least one empirically derived mathematical function having at least one independent variable; and

an interface control circuit coupled to the memory, the interface control circuit being adapted to receive a revised at least one empirically derived mathematical function from an external device, and store the revised at least one empirically derived mathematical function in the memory.

15. A circuit switched telecommunications network comprising the device of claim 1.

16. A packet switched telecommunications network comprising the device of claim 1.

17. A telecommunications switching device comprising the device of claim 1.

18. A method for evaluating quality in a telephonic voice connection in a telecommunications network, the method comprising:

establishing a telephonic voice connection;

measuring at least one characteristic of the telephonic voice connection; and

calculating a solution to at least one empirically derived mathematical function by using the at least one measured characteristic as an independent variable in the at least one empirically derived mathematical function, whereby the solution is an estimate of likely user perception of the quality of the telephonic voice connection.

19. The method of claim 18, wherein the at least one empirically derived mathematical function further comprises:

a first function (P_N) representing a proportion of users that will perceive the telephonic voice connection as having no impairment;

a second function (P_S) representing a proportion of users that will perceive the telephonic voice connection as having some impairment; and

a third function (P_M) representing a proportion of users that will perceive the telephonic voice connection as having much impairment, wherein $P_N + P_S + P_M = 1$.

20. The method of claim 18, wherein the at least one empirically derived mathematical function includes the equation:

$$P_N = \exp\,[-a(x-c)^b],$$

wherein P_N represents a proportion of users that will perceive the telephonic voice connection as having no impairment, a and b are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

21. The method of claim 18, wherein the at least one empirically derived mathematical function includes the equation:

$$P_M = 1 - \exp\,[-d(x-c)^e],$$

wherein P_M represents a proportion of users that will perceive the telephonic voice connection as having much impairment, d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

22. The method of claim 18, wherein the at least one empirically derived mathematical function includes the equation:

$$P_S = \exp\,[-a(x-c)^b] - \exp\,[-d(x-c)^e],$$

wherein P_S represents a proportion of users that will perceive the telephonic voice connection as having some impairment, a, b, d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

23. The method of claim 18, further comprising the step of providing a device for evaluating quality in a telephonic voice connection in a telecommunications network, the device includes a processor that is operative to calculate the solution to the at least one empirically derived mathematical function by using the at least one characteristic as an independent variable in the at least one empirically derived mathematical function.

24. The method of claim 23, further comprising the step of using the device to evaluate a portion of the telecommunications network.

25. The method of claim 24, wherein the portion of the telecommunications network is in service.

26. The device of claim 18, wherein the at least one characteristic is selected from the group consisting of C-message noise, magnitude of average power of speech, magnitude of average power of a quiet channel, echo path delay, echo path loss, a speech distortion indicator, and a dropped frame rate in a packet switched network.

27. The device of claim 18, wherein the network is a packet switched network

28. The device of claim 18, wherein the network is a circuit switched network.

29. A programmable device for evaluating quality in a telephonic voice connection in a telecommunications network, the device comprising:

a memory operative to store at least one empirically derived mathematical function having at least one independent variable;

a processor coupled to the memory, the processor being operative to calculate a solution to the at least one empirically derived mathematical function by using at least one measured characteristic as the independent variable, whereby the solution is an estimate of likely user perception of the quality of the telephonic voice connection; and

an interface control circuit coupled to the memory, the interface control circuit being adapted to receive a revised at least one empirically derived mathematical function from an external device, and store the revised at least one empirically derived mathematical function in the memory.

30. The programmable device of claim 29, further comprising:

a network interface, the network interface being operative to establish the telephonic voice connection between the device and the network; and

a measurement circuit coupled to the network interface, the measurement circuit being operative to measure the at least one measured characteristic of the telephonic voice connection.

31. The programmable device of claim 29, wherein the at least one empirically derived mathematical function includes the equation:

$$P_N = \exp\,[-a(x-c)^b],$$

wherein P_N represents a proportion of users that will perceive the telephonic voice connection as having no impairment, a and b are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

32. The programmable device of claim 29, wherein the at least one empirically derived mathematical function includes the equation:

$$P_M = 1 - \exp\,[-d(x-c)^e],$$

wherein P_M represents a proportion of users that will perceive the telephonic voice connection as having much impairment, d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

33. The programmable device of claim 29, wherein the at least one empirically derived mathematical function includes the equation:

$$P_S = \exp\,[-a(x-c)^b] - \exp\,[-d(x-c)^e],$$

wherein P_S represents a proportion of users that will perceive the telephonic voice connection as having some impairment, a, b, d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

34. The device of claim 29, wherein the at least one characteristic is selected from the group consisting of C-message noise, magnitude of average power of speech, magnitude of average power of a quiet channel, echo path delay, echo path loss, a speech distortion indicator, and a dropped frame rate in a packet switched network.

35. The device of claim 29, wherein the network is a packet switched network

36. The device of claim 29, wherein the network is a circuit switched network.

37. A method for fabricating a device for evaluating quality in a telephonic voice connection in a telecommunications network, the method comprising:

empirically acquiring user perception data by having at least one test subject listen to a plurality of test messages, and rate the quality of each test message in accordance with at least one user perceived impairment characteristic;

modeling the user perception data as at least one mathematical function, the at least one mathematical function being graphically represented by a two dimensional curve having a shape, the shape of the curve being determined by a set of constants employed in the at least one mathematical function;

choosing values for the set of constants to thereby fit the two-dimensional curve to the user perception data to thereby generate at least one empirically derived mathematical function;

converting the at least one empirically derived mathematical function into a set of computer executable instructions; and

programming the device with the set of computer executable instructions.

38. The method of claim 37, wherein the step of empirically acquiring user perception data further comprises the steps of:

selecting a plurality of user perceived impairment characteristics;

selecting a plurality of quality characteristics of the voice signal, each of the quality characteristics affecting the quality of the voice signal as perceived and described by users;

generating a plurality of voice messages by varying selected ones of the plurality of quality characteristics;

acquiring user perception data by having the at least one test subject listen to the plurality of voice messages, the at least one test subject rating the quality

of the plurality of voice messages in accordance with the plurality of user perceived impairment characteristics; and

transforming the each of the plurality of user perceived impairment characteristics into quantifications of each of the plurality of objective characteristics.

39. The method of claim 38, wherein the plurality of objective characteristics are selected from the group consisting of C-message noise, magnitude of average power of speech, magnitude of average power of a quiet channel, echo path delay, echo path loss, a speech distortion indicator, and a dropped frame rate in a packet switched network.

40. The method of claim 38, wherein the plurality of user perceived impairment characteristics includes volume level, noise level, speech distortion, and echo.

41. The method of claim 40, wherein the plurality of user perceived impairment characteristics are transformed into estimates, each estimate being a proportion of a population of users that would describe the telephonic voice connection as having no impairment, some impairment, or much impairment.

42. The method of claim 38, wherein the at least one empirically derived mathematical function includes a first function (P_N) representing a proportion of users that will perceive the telephonic voice connection as having no impairment, a second function (P_S) representing a proportion of users that will perceive the telephonic voice connection as having some impairment, and a third function (P_M) representing a proportion of users that will perceive the telephonic voice connection as having much impairment, where $P_N + P_S + P_M = 1$.

43. The method of claim 42, wherein the first function is characterized by the equation, $P_N = \exp[-a(x-c)^b]$.

44. The method of claim 43, wherein a and b are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

45. The method of claim 42, wherein the third function is characterized by the equation, $P_M = 1 - \exp[-d(x-c)^e]$.

46. The method of claim 42, wherein d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

47. The method of claim 42, wherein the second function is characterized by the equation, $P_S = \exp[-a(x-c)^b] - \exp[-d(x-c)^e]$.

48. The method of claim 47, wherein a, b, d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

49. A computer readable medium having computer executable instructions for performing a method, the method comprising:

establishing a telephonic voice connection;

measuring at least one characteristic of the telephonic voice connection; and

calculating a solution to at least one empirically derived mathematical function by using at least one measured characteristic as an independent variable of the at least one empirically derived mathematical function.

50. The method of claim 49, wherein the solution is an estimate of likely user perception of the quality of the telephonic voice connection.

51. The method of claim 49, wherein the at least one empirically derived mathematical function includes the equation:

$$P_N = \exp[-a(x-c)^b],$$

wherein P_N represents a proportion of users that will perceive the telephonic voice connection as having no impairment, a and b are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

52. The method of claim 49, wherein the at least one empirically derived mathematical function includes the equation:

$$P_M = 1 - \exp[-d(x-c)^e],$$

wherein P_M represents a proportion of users that will perceive the telephonic voice connection as having much impairment, d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

53. The method of claim 49, wherein the at least one empirically derived mathematical function includes the equation:

$$P_S = \exp[-a(x-c)^b] - \exp[-d(x-c)^e],$$

wherein P_S represents a proportion of users that will perceive the telephonic voice connection as having some impairment, a, b, d and e are empirically derived constants, and c represents a noise level that substantially all users would perceive as being unacceptable.

54. The method of claim 49, wherein the computer readable medium is selected from the group consisting of a DRAM, ROM, PROM, EEPROM, a hard drive, or compact disk.

55. The method of claim 49, wherein the method is performed by a telecommunications switching device coupled to the computer readable medium.

56. The method of claim 55, wherein the telecommunications switching device is disposed in a central office in a telecommunications network.

57. The method of claim 55, wherein the telecommunications switching device is a circuit switch.

58. The method of claim 55, wherein the telecommunications switching device is a packet switch.

59. The method of claim 49, wherein the method is performed by a Test Quality Measurement System (TQMS) coupled to the computer readable medium.

60. The method of claim 49, wherein the method is performed by a OEM equipment coupled to the computer readable medium.

61. A programmable device for evaluating quality in a telephonic voice connection in a telecommunications network, the device comprising:

a memory operative to store at least one empirically derived mathematical function having at least one independent variable;

an interface control circuit coupled to the memory, the interface control circuit being adapted to receive revised empirically derived data from an external device, and store the revised empirically derived data in the memory; and

a processor coupled to the memory, the processor being programmed to

calculate a revised at least one empirically derived mathematical function using the revised empirically derived data, and

calculate a solution to the revised at least one empirically derived mathematical function by using at least one measured characteristic as the independent variable, whereby the solution is an estimate of likely user perception of the quality of the telephonic voice connection.